Isolation Packer Inflated by a Fluid Filtered from a Gravel Laden Slurry

Inventor: Travis T. Hailey, Jr.

Attorney Docket: **2003-IP-009460 U1 USA**

CERTIFICATE OF MAILING BY "EXPRESS MAIL"

"Express Mail" Mailing Label Number EU 640 230 502 US, Date of Deposit August 20, 2003. I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 C.F.R. § 1.10 on the date indicated above and is addressed to the MAIL STOP PATENT APPLICATION, Commissioner for Patents, P. O. Box 1450, Alexandria, VA 22313-1450.

ANNIE N. MATHEW	Annie N. Mathew	AUGUST 20, 2003
Type or Print Name of Person Mailing	Signature of Person Mailing	Date

ISOLATION PACKER INFLATED BY A FLUID FILTERED FROM A GRAVEL LADEN SLURRY

TECHNICAL FIELD

[0001] This invention generally relates to inflatable packers used to complete subterranean wells and in particular to hydraulically actuated inflatable packers. More specifically, this invention relates to hydraulically actuated inflatable packers that are inflated by a fluid filtered from a gravel laden slurry or other fluid with suspended solids.

BACKGROUND OF THE INVENTION

[0002] Oil and natural gas may be obtained from subterranean geologic formations, referred to as reservoir, by drilling wells that penetrate hydrocarbon-bearing formations. In order to obtain hydrocarbons from a wellbore, the well usually must be completed.

[0003] Well completion involves the design, selection, and installation of equipment and materials in or around a wellbore for conveying, pumping, or controlling the production or injection of fluids from and/or to the wellbore. After a well has been completed, production of oil and gas may begin. Sand or silt flowing into the wellbore from unconsolidated formations may lead to an accumulation of fill within the wellbore which may cause a reduction of production rates and damage to surface and subsurface production equipment. The fill, often referred to as migrating sand, has the possibility of packing off around subsurface production equipment, or may enter the production tubing and therefore enter production equipment. Sand is highly abrasive, and if it enters production streams, it may

cause the erosion of tubing, flowlines, valves and other processing components and equipment. Erosion and abrasion caused by sand production often increases operational and maintenance expenses, and in severe cases may lead to a total loss of the well. Gravel packing is a means of controlling sand production. Gravel packing is the placement of relatively large sand (i.e., “gravel”) around the exterior of a sand screen or liner, which includes slotted sand screens, perforated sand screens, and various other liner types and screens. The gravel acts as a filter to remove formation fines and sand from oilfield fluids.

[0004] A gravel pack completion known in the art comprises a sand screen that is placed in the wellbore and positioned within an unconsolidated formation. The sand screen may be connected to a tool that includes a production packer and a cross-over. The tool is connected to a work string or a production tubing string. Gravel is then pumped in a slurry down the tubing and through the cross-over, thereby flowing into the annulus between the sand screen and the wellbore. The slurry comprises a liquid supporting suspended solids. The solids are often referred to as “gravel”. The liquid leaks off into the formation and/or through the sand screen, which is sized to prevent the solids in the slurry from flowing through. Thus the solids are deposited in the annulus around the sand screen where it forms a gravel pack. The sand screen prevents the gravel pack from entering into the production tubing. The gravel must be sized for proper containment of the formation sand, and the sand screen must be designed in a manner to prevent the flow of the gravel through the sand screen.

[0005] Often during well completions there is a need to seal off sections of the wellbore. One reason to seal off a section of a wellbore is the need to isolate those areas in which an adequate gravel pack can not be obtained, such as below the

bottom of the gravel pack screens where adequate circulation is difficult to achieve. Another reason to seal off a section of a wellbore is that in some formations, such as across a major or minor shale section, a gravel pack completion is not desirable. Still another reason to seal off a section of a well bore is because when one or more sections are to be completed and another section is not going to be completed, the non-completed section often needs to be isolated from the sections that will be completed. This is due to the fact that when non-completed sections are not isolated, the gravel, which is tightly packed around the gravel pack screens after a gravel pack, may be able to migrate to these non-completed sections, thereby limiting the effectiveness of the gravel pack completion. Another reason to isolate a section of the wellbore is to prevent or limit acceleration of the gravel migration effect due to the flow of produced fluids. Sand screens exposed to gravel migration due to the flow of produced fluids may experience direct production of formation sand which could result in equipment damage, formation collapse and even the loss of the well.

[0006] Well known in the art are inflatable packers, usually comprising an annular elastomeric bladder, which have been used to seal off sections of wellbores for the reasons discussed above. When the bladder is filled by a by a pressurized fluid, it inflates the packer causing the exterior of the elastomeric body to seal against the wellbore. This produces a wellbore seal that prohibits fluid flow past the packer.

[0007] A problem with inflatable packers known in the art is the difficulty of sending fluid to the bladder to inflate the bladder. The time consumed in using known inflatable packers includes the time needed for an extra step either prior to the gravel pack step or after the gravel pack step to send a specialized tool down the wellbore to inflate the packer.

[0008] Thus, there is a need for an improved inflatable packer which reduces the known problems in sending fluid to the bladder to inflate the bladder, and eliminates the need for an extra step either prior to or after a gravel pack to inflate the bladder.

SUMMARY OF THE INVENTION

[0009] The present invention describes tools and methods of completing a wellbore that comprise an isolation packer with a particulate filter and inflatable element. The isolation packer is adapted to direct a gravel laden slurry to the particulate filter, where the filter removes a substantial amount of the particulate matter from the gravel laden slurry thereby producing an inflating fluid that is substantially free of particulate matter. The inflating fluid then inflates the inflatable element thus creating a seal in the wellbore.

[0010] This invention offers a number of benefits over conventional wellbore completion tools. Usually a pre-gravel pack trip would be undertaken to isolate a sump area, for instance, with a cement plug or an open hole packer. This pre-gravel pack trip comprise additional steps that are costly, time consuming and are often difficult to perform and unreliable in their outcome. The present invention provides a means of achieving the desired results in the same trip into the well as the gravel pack operation. The ability to inflate the inflatable isolation packer during a gravel pack completion can save time and expense by eliminating an additional trip into the well.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The above advantages as well as specific embodiments will be understood from consideration of the following detailed description taken in conjunction with the

appended drawings in which:

[0012] Figure 1 is a cross section of a wellbore showing a prior art gravel pack completion apparatus.

[0013] Figure 2 is a cross section of a wellbore showing a gravel pack completion apparatus that includes an embodiment of the present invention.

[0014] Figures 3A and 3B are cross sections of a wellbore showing a gravel pack completion with both a typical isolation packer (Fig. 3A) and with a cup packer (Fig. 3B)with the particulate filter located near an uphole end of the conduit.

[0015] Figure 4 is a cross section of a wellbore showing an embodiment of the present invention with the inflatable element shown in an inflated state.

[0016] Figure 5 is a partial cut away view of another embodiment of the present invention comprising an alternative channel.

[0017] Figure 6 is a partial cut away view of the present invention comprising an alternative channel with the particulate filter located near an uphole end of the alternative channel.

[0018] Figure 7 is a partial cut away view of the alternative channel embodiment of the present invention showing the inflatable element in an inflated state.

[0019] Figure 8 is a cross section of a wellbore showing another embodiment of

the present invention in an openhole completion.

[0020] Figure 9 is a cross section of a wellbore showing the embodiment of the present invention in an openhole completion with the inflatable element in an inflated state.

[0021] References in the detailed description correspond to like references in the figures unless otherwise indicated.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0022] Referring to the attached drawings, FIG. 1 is a depiction of the prior art and illustrates a wellbore 10 that has penetrated a subterranean zone 12 that includes a productive formation 14. The wellbore 10 has a casing 16 that has been cemented in place. The casing 16 has a plurality of perforations 18 which allow fluid communication between the wellbore 10 and the productive formation 14. A well tool 20 is positioned within the casing 16 in a position adjacent to the productive formation 14, which is to be gravel packed.

[0023] The present invention can be utilized in both cased wells and open hole completions, as well as vertical wells and non-vertical wells. For ease of illustration of the relative positions of the producing zones in FIGs. 1-4, a cased well having perforations will be used. More detailed illustrations of the invention being utilized in an open hole completion are shown in FIGs. 8-9.

[0024] Still referring to FIG. 1, the well tool 20 comprises a tubular member 22

attached to a production packer 24, a closing sleeve 26, and one or more sand screen elements 28. Blank sections of pipe may be used to properly space the relative positions of each of the components. An annulus area 34 is created between each of the components and the wellbore casing 16. The combination of the well tool 20 and the tubular string extending from the well tool to the surface can be referred to as the production string.

[0025] Still referring to FIG. 1, in a gravel pack operation the packer 24 is set to ensure a seal between the tubular member 22 and the casing 16. Gravel laden slurry is pumped down the tubular member 22, exits the tubular member through ports in the closing sleeve 26 and enters the annulus area 34 below the production packer 24. In one typical embodiment the particulate matter (gravel) in the slurry has an average particle size between about 40/60 mesh-12/20 mesh, although other sizes may be used. Slurry dehydration occurs when the carrier fluid leaves the slurry. The carrier fluid can leave the slurry by way of the perforations 18 and enter the formation 14. The carrier fluid can also leave the slurry by way of the sand screen elements 28 and enter the tubular member 22. The carrier fluid flows up through the tubular member 22 until the closing sleeve 26 places it in the annulus area 36 above the production packer 24 where it can leave the wellbore 10 at the surface. Upon slurry dehydration the gravel grains should pack tightly together. The final gravel filled annulus area is referred to as a gravel pack.

[0026] An area that is prone to developing a void during a gravel pack operation is the area 42 below the lowest sand screen element 28, sometimes referred to as the "sump". A gravel pack void in the sump 42 is particularly problematic in vertical wells in that it can allow the gravel from above to settle and fall into the voided sump.

[0027] Production of fluids from the productive formation 14 can agitate or “fluff” the gravel pack and initiate the gravel to migrate and settle within the sump 42. This can lead to the creation of voids in the annulus areas 38 adjacent to the sand screen elements 28 and undermine the effectiveness of the entire well completion.

[0028] As used herein, the term “sand screen” refers to wire wrapped screens, mechanical type screens and other filtering mechanisms typically employed with sand screens. Sand screens need to be have openings small enough to restrict gravel flow, often having gaps in the 60-12 mesh range, but other sizes may be used. Sand screens of various types are produced by Halliburton, among others, and are commonly known to those skilled in the art.

[0029] FIG. 2 illustrates one particular embodiment of the present invention where an upper set of perforations 60 and a lower set of perforations 62 will be completed utilizing a gravel pack completion. The lower set of perforations 62 will be isolated from the upper set of perforations 60. An inflatable isolation packer 50 is run into the wellbore 10 below the lowest sand screen element 28. A conduit 52 extends from the gravel inflated isolation packer 50 and provides communication with the annulus area 38 that will be gravel packed. The conduit 52 may be generally referred to as a passageway, and more specifically referred to as a shunt tube. A second conduit 53 may be utilized below the isolation packer 50.

[0030] Between the conduit 52 and the gravel inflated isolation packer 50 is a particulate filter 54. Likewise, a particulate filter 59 is placed between conduit 53 and the isolation packer 50. In this way, either or both of the conduits 52, 53 allow

gravel laden slurry to travel from the annulus area 38 to the particulate filters 54, 59 where the gravel laden slurry is filtered, thereby providing an inflating fluid. The inflating fluid is then communicated to an inflatable element 56 that provides the sealing mechanism between the tubular member 22 and the casing 16. The inflatable element 56 may be an expandable bladder. The particulate filter 54 could be any device known in the art that separates the particulate matter in the gravel laden slurry from the carrying fluid. Some examples of particulate filters include, but are not limited to: wire-wrapped screens and wire meshes.

[0031] A conduit, such as conduit 52 and/or conduit 53, is just one way of enabling the communication of the gravel laden slurry to enter the inflatable isolation packer 50. Other embodiments can be used, such as connecting the inflatable isolation packer 50 to a flow channel which is integral to the screen, or a shunt tube. All of these embodiments would include a particulate filter to prevent particulates such as gravel from entering the inflatable element 56. In addition, all of these embodiments may include a check valve device to prevent any reverse flow out of the inflatable isolation packer 50.

[0032] The inflation of the inflatable element 56 will typically be done with a fluid that is filtered from a gravel laden slurry. This fluid will be an inflating fluid that is substantially free of particulates such as gravel. The inflation of the inflatable element 56 can be performed in conjunction with a gravel pack completion operation of the well.

[0033] The inflatable element 56 may be constructed utilizing an inner elastomeric element that retains the pressurized fluid that is used to inflate the packer. The

inflatable element may comprise more than one layer of material, such as utilizing an expandable mesh as an outer layer for durability. Often a plurality of metal reinforcing members can be located in the annulus between the elastomeric element and the outer expandable mesh, these provide additional strength to the packer and can improve reliability. The typical construction can be in the manner of conventional packers, these methods and materials being well known to those skilled in the art.

[0034] FIGURES 3A and 3B illustrate alternate embodiments of the invention where the particulate filter 54 is no longer located adjacent to the inflatable element 56, but rather is now located near the uphole end of the conduit 52. The particulate filter 54 may be located at various locations on the well tool 20 so long as the particulate filter is able to filter the particulates from the gravel slurry so that an inflating fluid is produced that is substantially free of particulate matter and can be used to inflate the inflatable element 56. Multiple conduits may be used, one or more with ports as depicted in FIG. 2 in addition to one or more without ports as shown in FIG. 3A, as long as at least one conduit supplies inflating fluid through a particulate filter that can inflate the inflatable element.

[0035] FIG. 3B shows the use of a cup packer 55 placed below the entrance to conduit 52 but above the first opening of sand screen elements 28. As is known in the arts, the use of a cup packer, such as cup packer 55, creates a pressure seal between well tool 34 and the well bore wall 16 except for the passage way through the conduit, such as conduit 52, or the conduits allowing a forced flow through the conduit or conduits.

[0036] FIG. 4 illustrates the embodiment of the invention as described in FIG. 2 after a gravel pack operation has been performed. The inflatable element 56 of the inflatable isolation packer 50 is expanded and provides a seal between the tubular member 22 and the casing 16. The upper and lower set of perforations 60 and 62 have been properly gravel packed and protected from the producing formation 14. The inflatable isolation packer 50 acts to isolate the gravel pack completed lower set of perforations 62 from the gravel pack completed upper set of perforations 60. Also shown in FIG. 4 is the use of a second isolation packer 150 which can be used and operated in a manner similar to isolation packer 50.

[0037] For ease of installation and to ensure proper placement relative to the components of the well tool 20, the conduit 52 that extends from the inflatable isolation packer 50 will typically be attached to the exterior of the well tool 20 in some manner, such as by welding. It is also possible for the conduit 52 to be replaced by a fluid pathway forming an alternative channel within a sand screen element, as described with respect to FIGs. 5-7. Also, the particulate filters may be located adjacent or near the inflatable element 56.

[0038] Referring now to FIG. 5, there is depicted a partial cut away view of an apparatus 64 that is an alternative channel embodiment of the invention. Apparatus 64 has an outer tubular 66. A portion of the side wall of outer tubular 66 is an axially extending production section 68 that includes a plurality of openings 70. Another portion of the side wall of outer tubular 66 is an axially extending nonproduction section 72 that is distinguished from the production section 68 by the lack of openings 70. It should be noted by those skilled in the art that even though FIG. 5 has depicted openings 70 as being circular, other shaped openings may alternatively be used without departing from the principles of the present invention.

In addition, the exact number, size and shape of openings 70 are not critical to the present invention, so long as sufficient area is provided for fluid production therethrough and the integrity of outer tubular 66 is maintained.

[0039] Still referring to FIG. 5, disposed within outer tubular 66 and on opposite sides of each other is one or more channels 74, only one channel 74 being visible. Channels 74 provide circumferential fluid isolation between production section 68 and nonproduction section 72 of outer tubular 66. Channels 74 may be generally referred to as passageways.

[0040] Still referring to FIG. 5, disposed within channels 74 is a sand control screen assembly 78. The sand control screen assembly 78 may include a base pipe 80 that has a plurality of openings 82 which allow the flow of production fluids into the production tubing. The exact number, size and shape of openings 82 are not critical to the present invention, so long as sufficient area is provided for fluid production and the integrity of base pipe 80 is maintained. Positioned around base pipe 80 is a fluid-porous, particulate restricting, sintered metal material such as plurality of layers of a wire mesh that are sintered together to form a porous sintered wire mesh screen 84. Sand screen 84 is designed to allow fluid flow therethrough but prevent the flow of particulate materials of a predetermined size from passing therethrough. It should be understood by those skilled in the art that other configurations of the sand screen assembly 78 may be used in conjunction with the alternative channel embodiment 64 of the invention, for instance, the sand screen assembly may also have a screen housing located between the channels 74 and the sand screen 84, or different screening materials may be used in stead of the sand screen 84.

[0041] Still referring to FIG. 5, in this embodiment, the channels 74 are analogous to the conduit 52 from FIGs. 2-4, in that a gravel laden slurry may travel down the channels 74 to a particulate filter 54, which filters out particulates such as gravel. Once the gravel laden slurry is filtered, a substantially particulate-free fluid thereby communicates with an inflatable isolation packer 50 and expands inflatable element 56. FIG. 6 shows another embodiment of the alternative channel apparatus 64 wherein the particle filter 54 is located nearer the uphole end of the alternative channel 74, instead of being adjacent to the inflatable isolation packer 50. FIG. 7 shows the alternative channel apparatus 64 with the inflatable element 56 expanded to form a seal with the casing 16 to isolate the annular area 38 from the space 86 below the packer

[0042] FIG. 8 illustrates an embodiment of the gravel inflated isolation packer 50 utilized in an openhole environment. This embodiment comprises a tubular member 22, a conduit 52, two particulate filters 54, an expandable element 56, an upper packer head 88, and a lower packer head 90. This illustration shows an embodiment of the present invention wherein the conduit 52 extends out both the upper packer head 88 and the lower packer head 90. The conduit 52 provides two pathways, one for communication to the expandable element 56, and the second for communication to annular areas 92 and 94.

[0043] FIG. 9 shows the inflatable isolation packer 50 as illustrated in FIG. 8 and described above with the inflatable element 56 in an inflated state and filled with inflating fluid. The inflated inflatable element 56 forms a seal between in the wellbore thereby isolating annular area 92 from annular area 94.

[0044] The inflatable isolation packer 50 acts to isolate a first zone from a second zone within the well. In FIG. 4, an annulus area that is gravel packed is being isolated from a lower annulus area of the well that is also gravel packed. Other embodiments can be used to separate a gravel packed annulus area from a non-gravel packed annulus area, a gravel packed annulus area from a sump area or other combinations such as these. In other embodiments, a lateral wellbore may be isolated from a main wellbore, multiple lateral wellbores may be isolated from each other, and length of a lateral wellbore being gravel packed may be effectively shortened. The ability to inflate the inflatable isolation packer 50 during a gravel pack completion can save time and expense by eliminating an additional trip into the well.

[0045] FIGs. 1-3 shows the invention used between two gravel packed zones, whereby the invention is isolating the two gravel packed zones from each other. This embodiment can be used to selectively work on or produce from the separate zones.

[0046] In another embodiment the invention may be placed below the lowest perforation or at the bottom of the well. This embodiment may be used to isolate the lower areas from the completed zones without permanently reducing the total depth of the well. Thus, the well could be functionally plugged back to where the inflatable isolation packer was located and leaving open the option of removing the inflatable isolation packer for the completion of deeper zones in the future.

[0047] The discussion and illustrations within this application may refer to a vertical wellbore that has casing cemented in place, or is an openhole bore, and

comprises casing perforations to enable communication between the wellbore and the productive formation. It should be understood that the present invention can also be utilized with wellbores that have an orientation that is deviated from vertical.

[0048] The particular embodiments disclosed herein are illustrative only, as the invention may be modified and practiced in different but equivalent manners apparent to those skilled in the art having the benefit of the teachings herein. Furthermore, no limitations are intended to the details of construction or design herein shown, other than as described in the claims below. It is therefore evident that the particular embodiments disclosed above may be altered or modified and all such variations are considered within the scope and spirit of the invention. Accordingly, the protection sought herein is as set forth in the claims below.